

Holocene climate-vegetation-fire Interactions: lessons from high-latitude and high-elevation ecosystems



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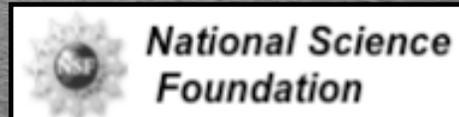
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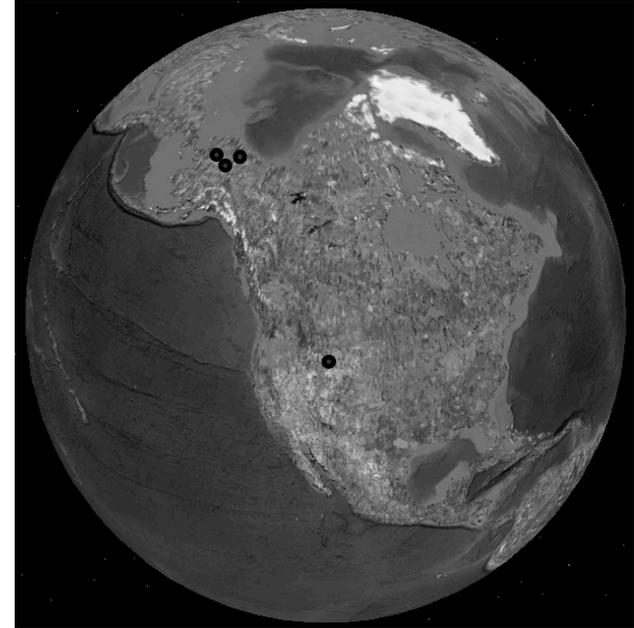
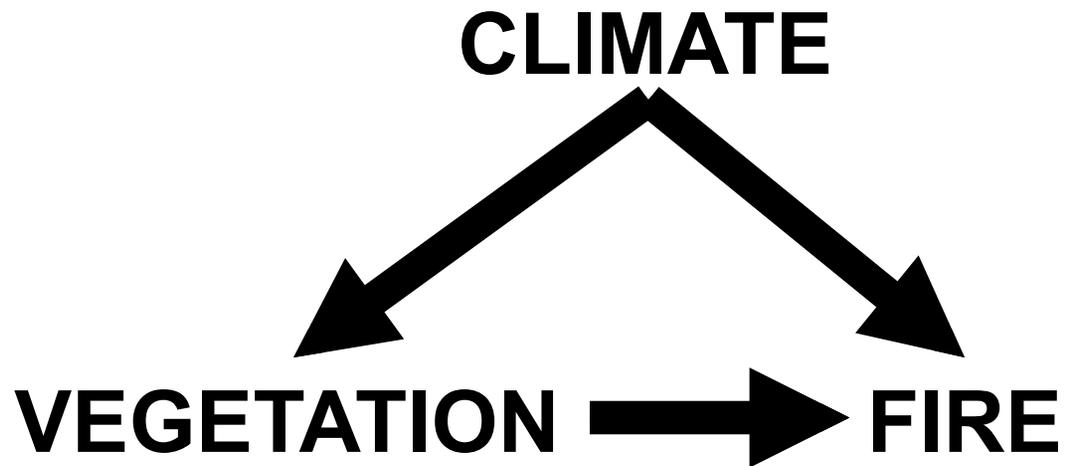


Joint Fire Science Program

Research Supporting Sound Decisions

www.firescience.org

Climate – Vegetation – Fire Interactions



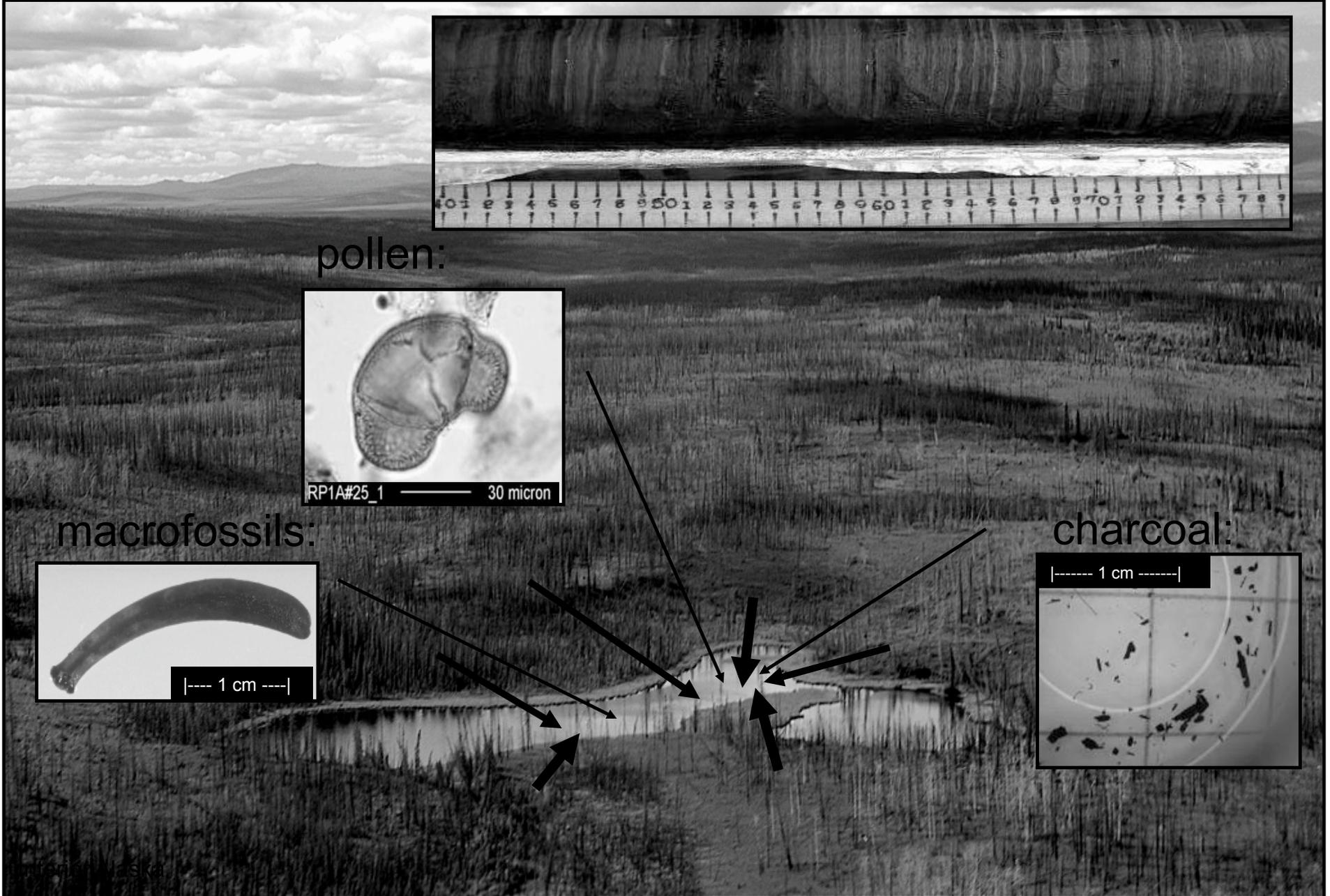
1. Climate → Area burned:

- Yellowstone subalpine forests
- Alaskan tundra

2. Climate → Vegetation → Fire frequency:

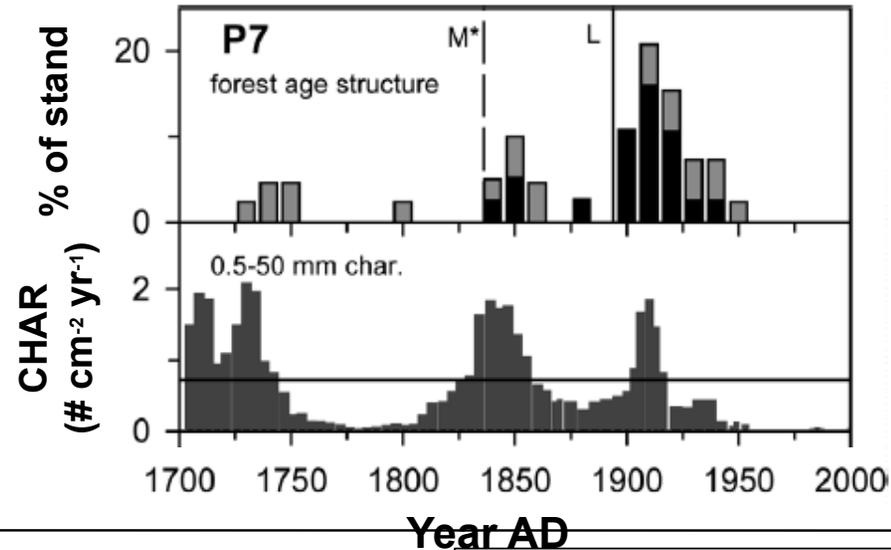
- South-central and western Brooks Range forest and tundra

Paleo records of fire, vegetation, and climate



Fire history from continuous sediment records

Empirical support:

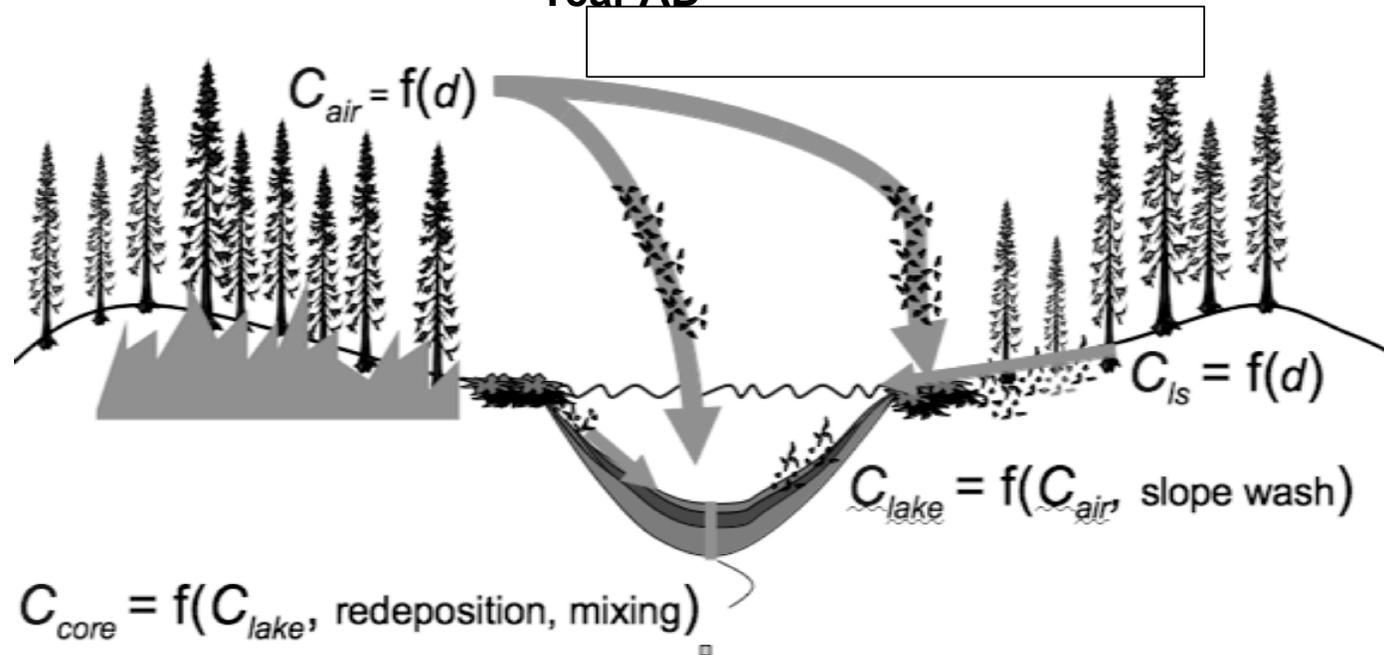


Stand age & fire scars

Charcoal accumulation

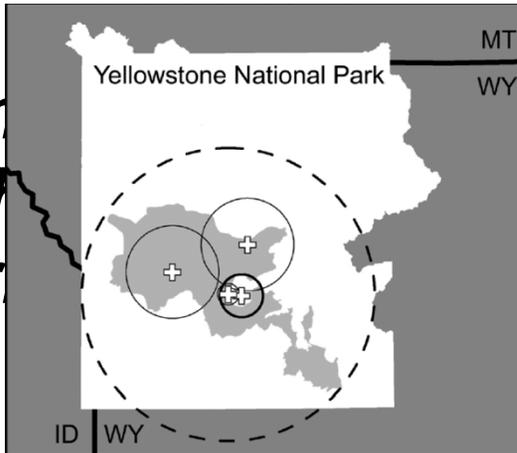
Higuera et al. 2005

Theoretical support:

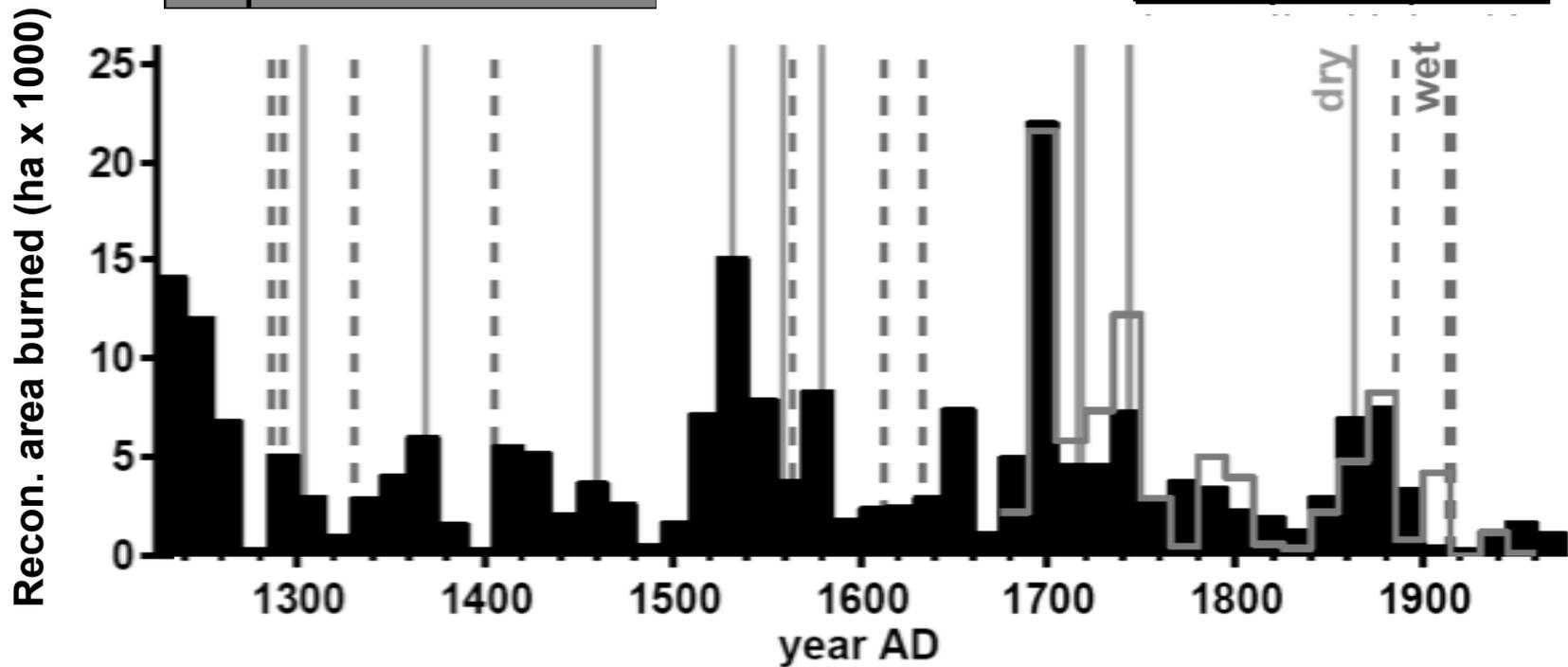
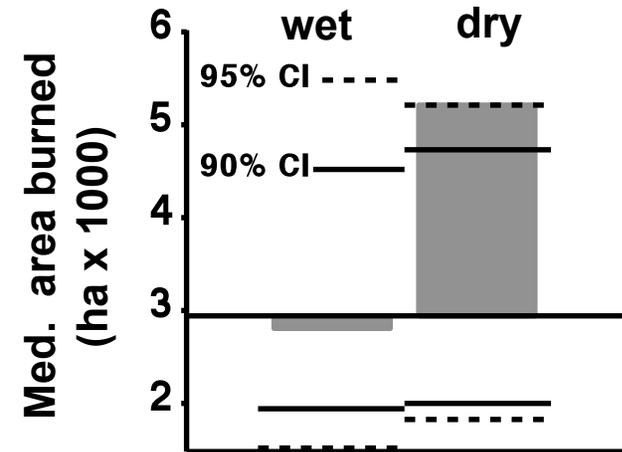


Yellowstone subalpine forests: climate → area burned

*Extremely
with
burn*



*associated
area
50 yr*

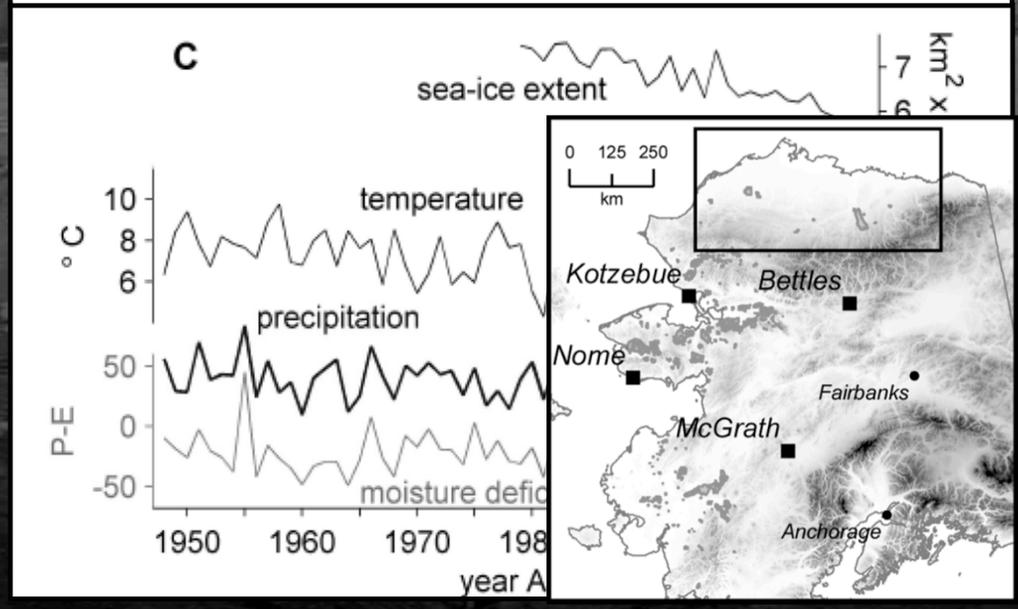
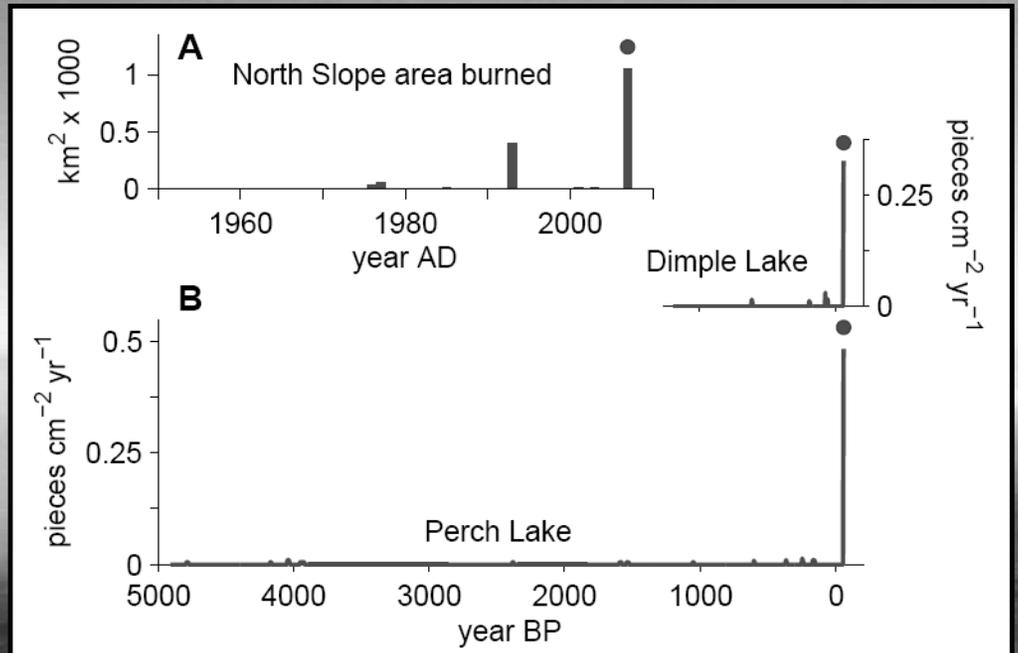


Higuera, Whitlock, Gage, in review. Precipitation record: Gray et al. 2007; Tree-ring record: Romme and Despain 1989.

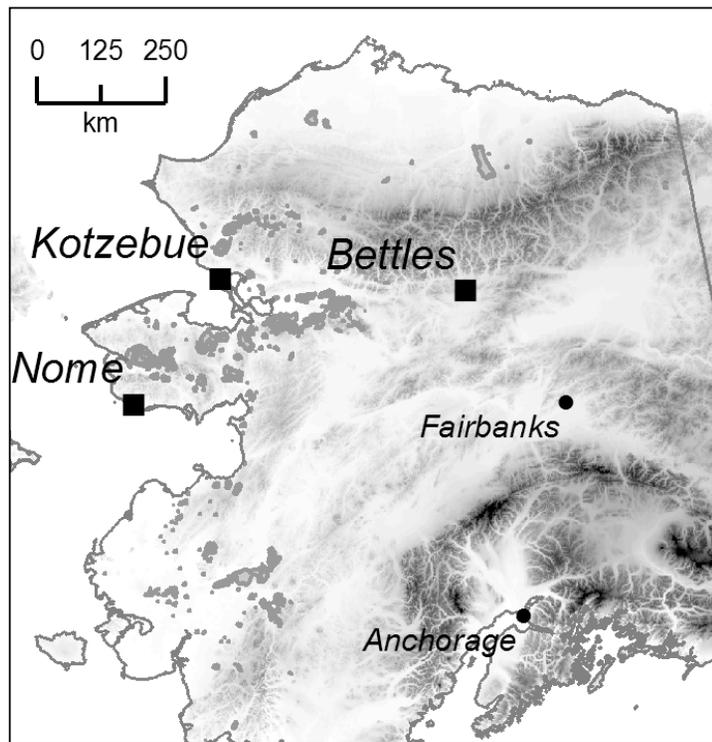
P. Higuera: B32A

Central Arctic Foothills, Alaska

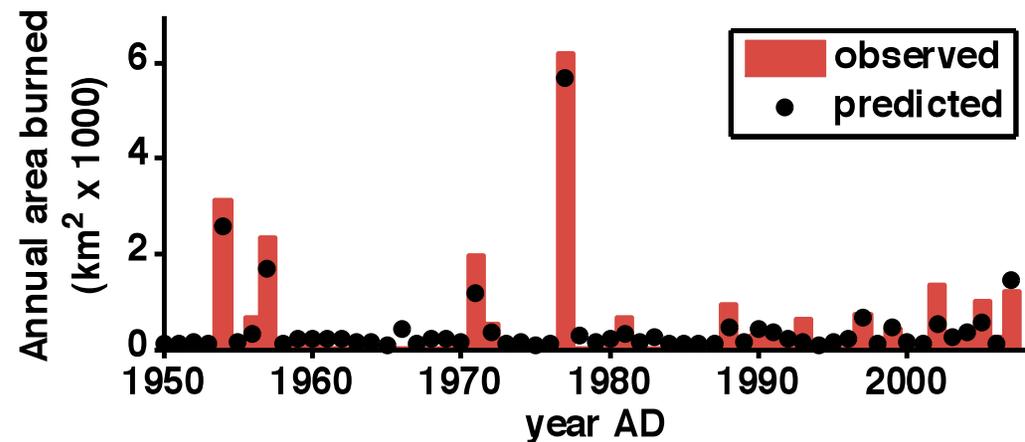
F. S. Hu, P. E. Higuera,
 J. E. Walsh, W. L. Chapman,
 P. A. Duffy, L. B. Brubaker,
 M. L. Chipman



Alaskan tundra: climate → area burned



Area burned in Alaskan tundra:
 $r^2 = 0.94$

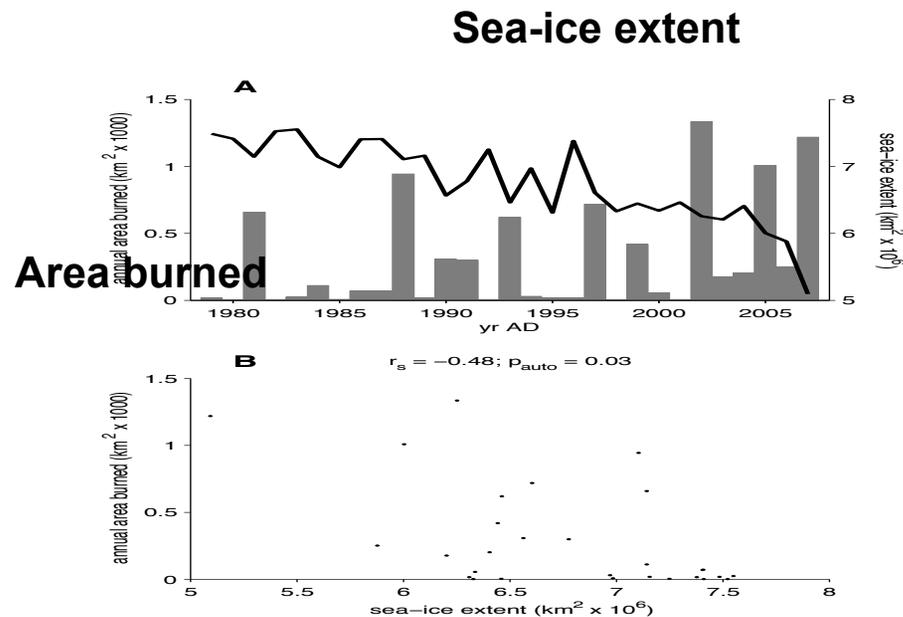


In prep., with Paul A. Duffy

Alaskan tundra fires & Northern Hemisphere sea ice

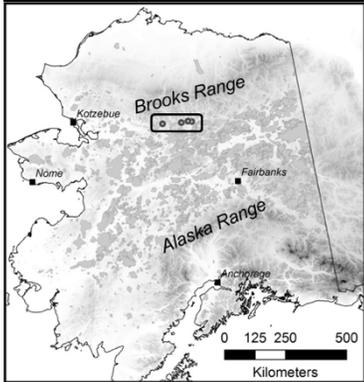
****Marine-terrestrial feedbacks likely important for tundra fire regimes***

$$r = -0.49$$



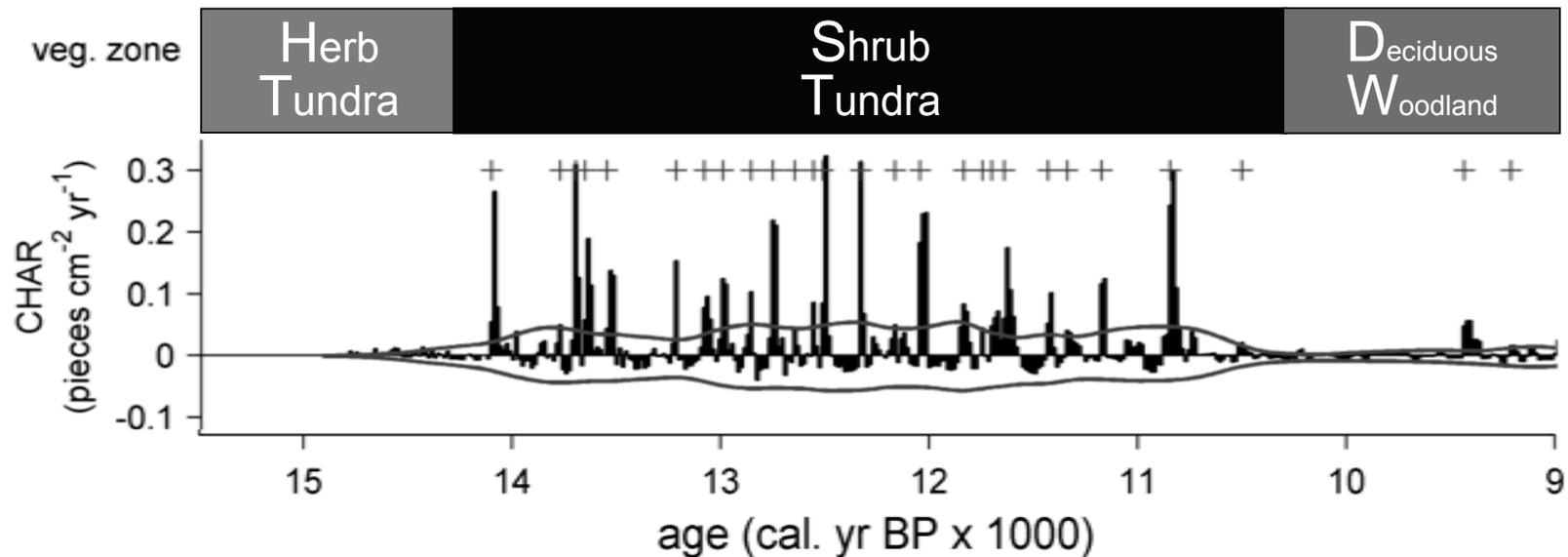
year AD

South-central Brooks Range, Alaska



****Changes in flammability can amplify or dampen the direct impact of climate***

Long-term trend toward warmer climate →



Higuera et al. 2008, *PLoS ONE* 3: e0001744

Higuera et al. 2009. Brooks Range Fire History. *Ecological Monographs* 79: 201-219.

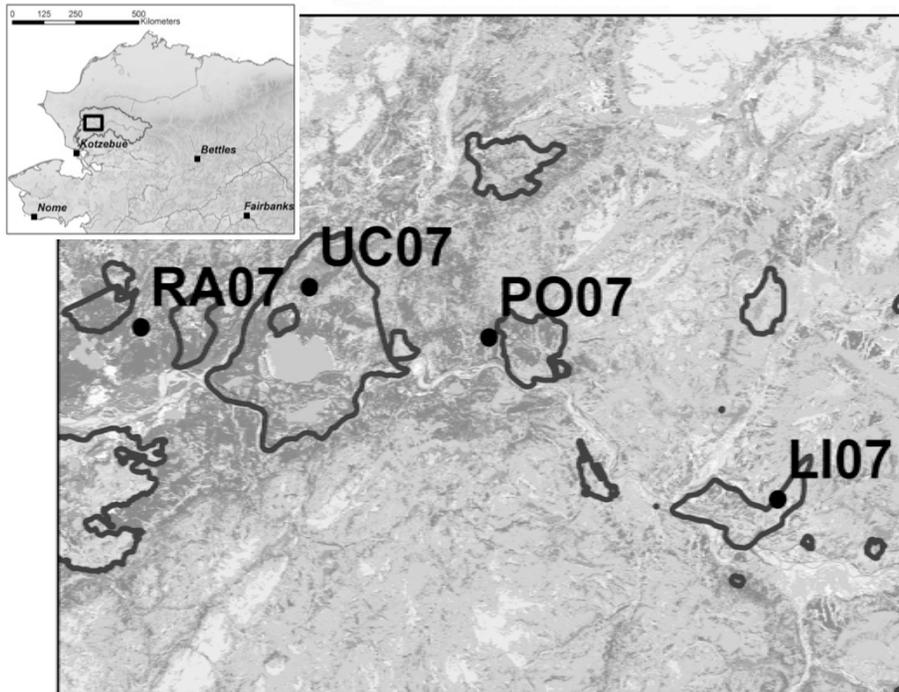
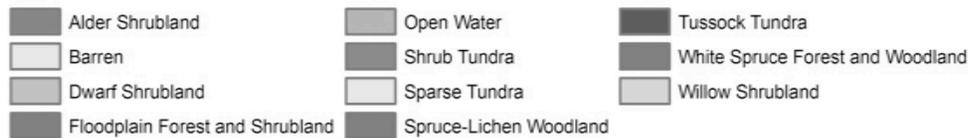
Brubaker et al. 2009. Charcoal Records and Ecological Modeling. *Ecology* 90: 1788-1801.

Tinner et al. 2008. Climatic Change and Boreal Ecosystems. *Ecology*: 89: 729-743.

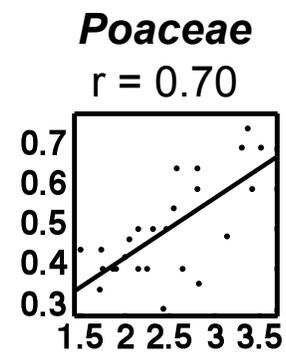
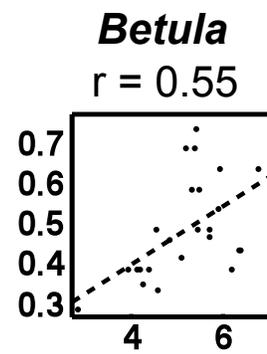
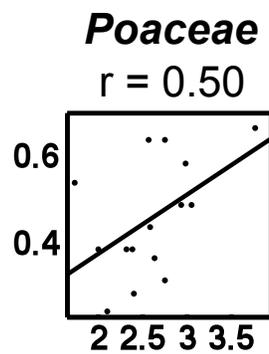
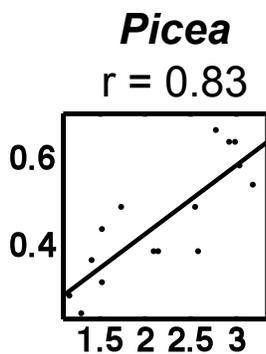
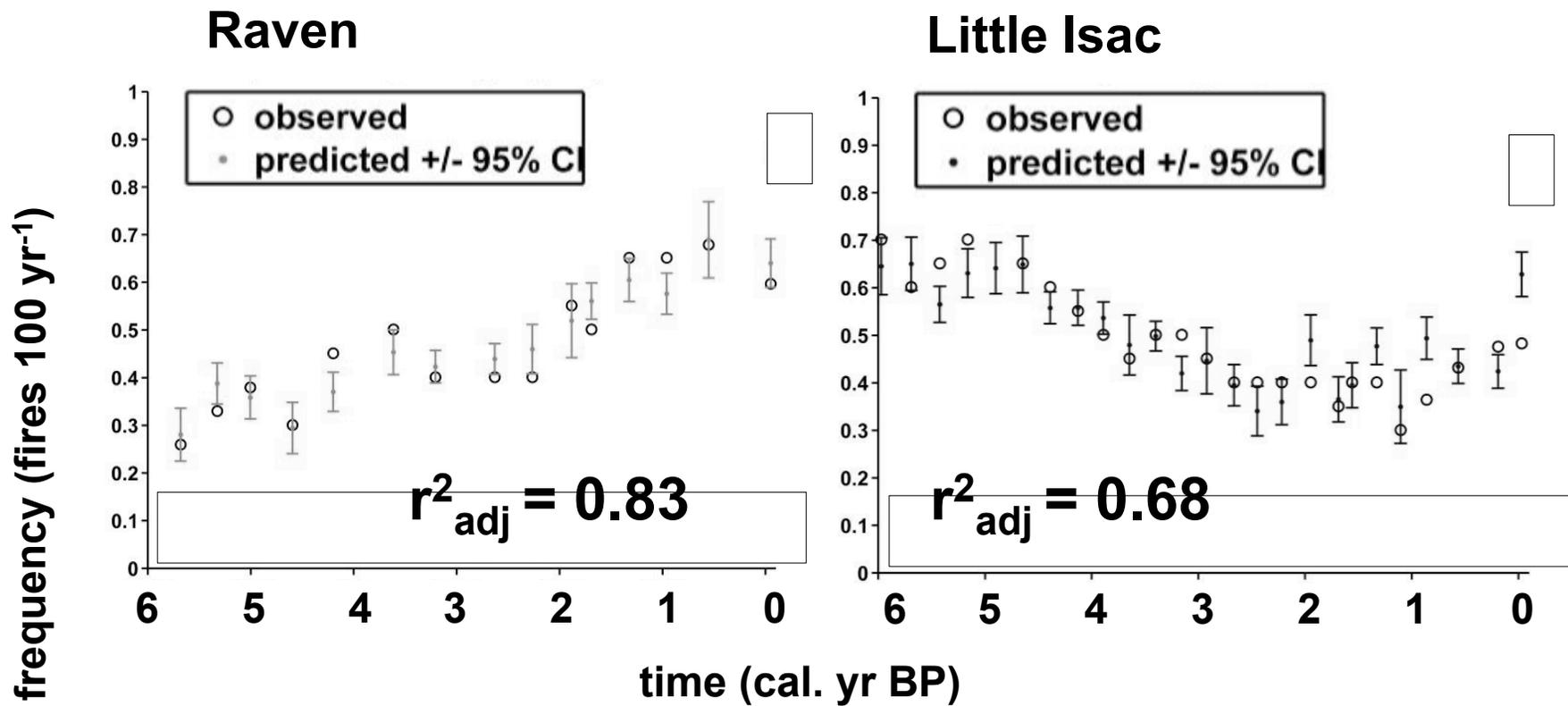
Western Brooks Range, Alaska

* See poster *Thursday AM: PP41B-1517*, M. Chipman

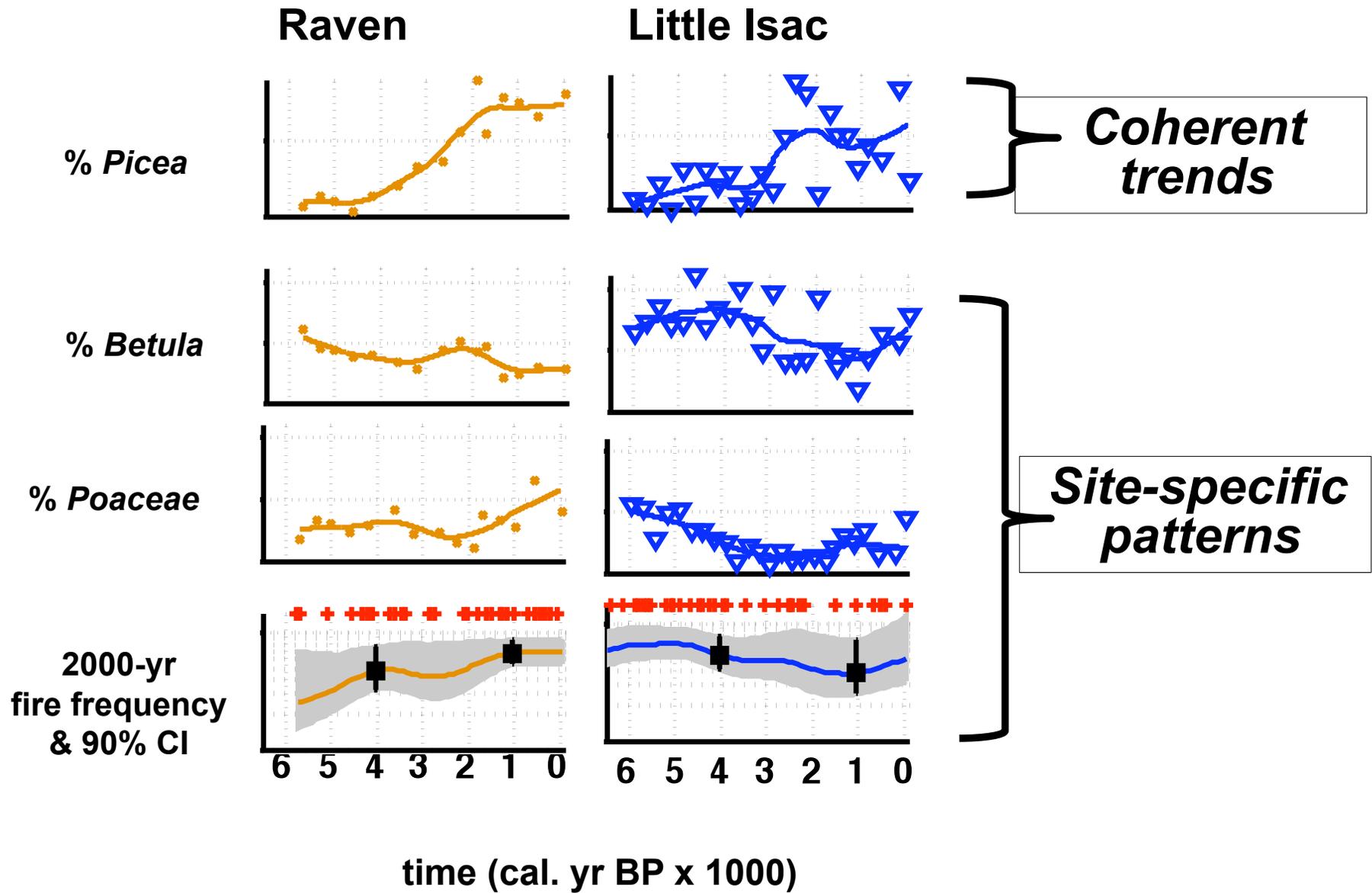
Locally-mediated response to climate change



Raven Lake

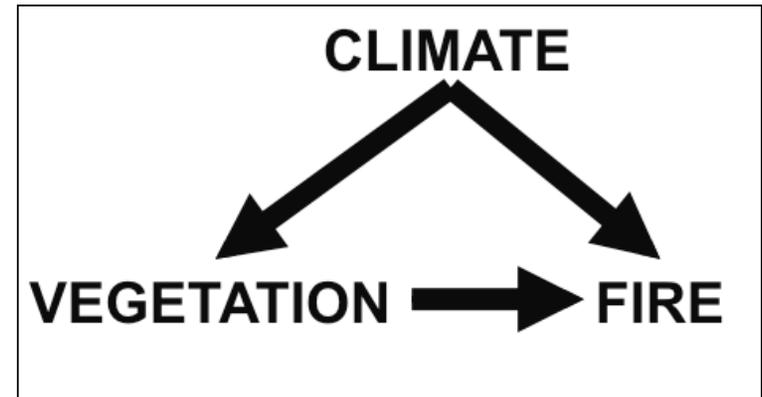


Squrt.-transformed pollen percentage



Summary

- Holocene records provide insights into key biophysical interactions

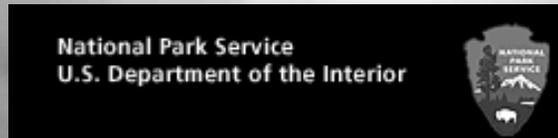
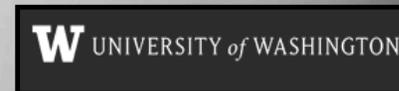


- Climate → fire linkages strong in both forest and tundra ecosystems
- Impacts of climate change on fire regimes can be amplified or dampened by vegetation

Acknowledgments & Questions

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<http://webpages.uidaho.edu/phiguera/>

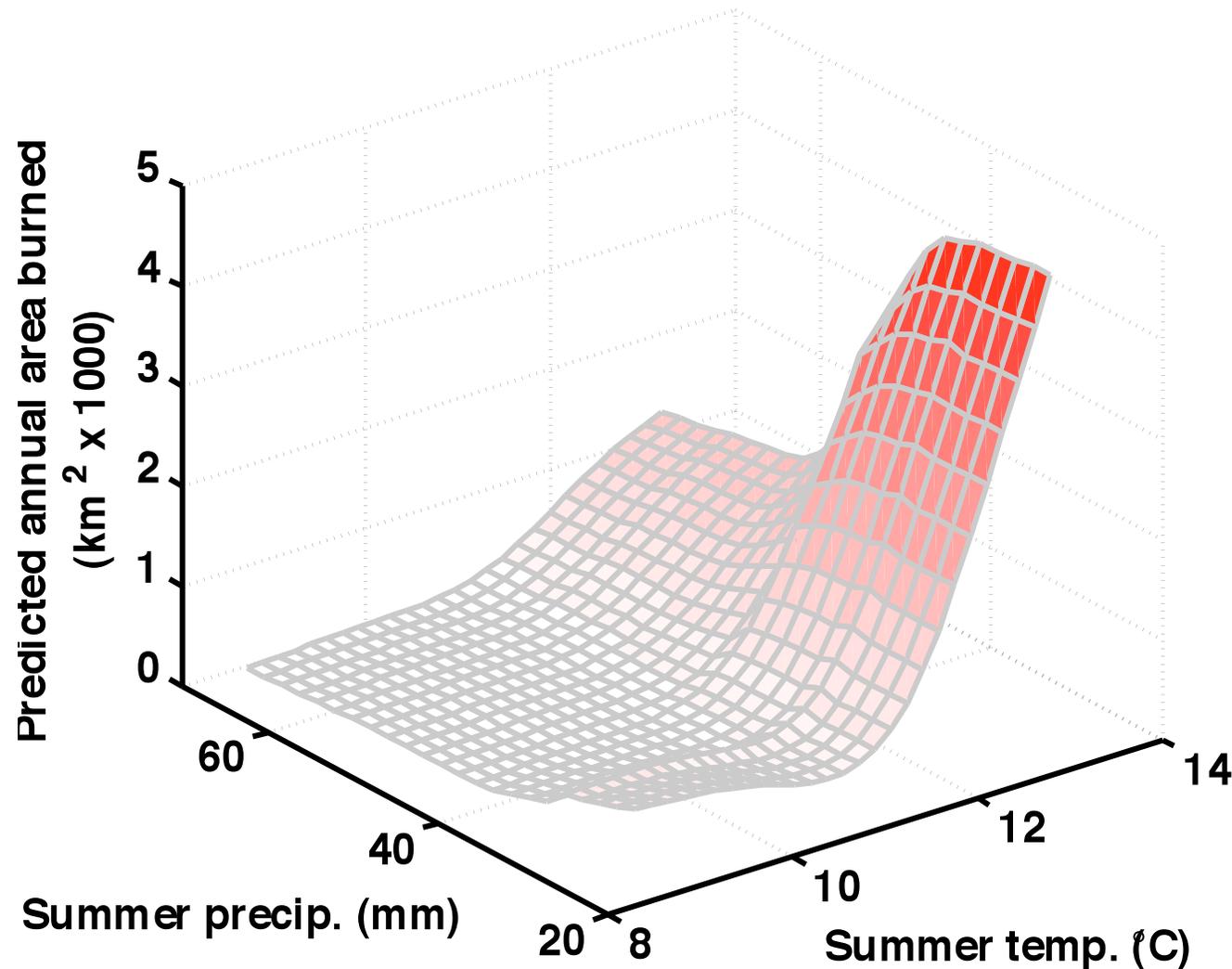


Field & Lab Assistance:

- Claire Adam
- Christy Briles
- Ben Clegg
- Brian Cudaback
- Rebecca Ebert
- Katie Franz
- Jennifer Leach
- Amy Lilienthal
- John Mauro
- Dave McWethy
- NPS personnel
- Ashlee Peery
- Kate Shick
- Andrew Whitmore
- Jason Smith
- Jennifer Schwarz
- Emily Spaulding
- Triet Vuong

“...it is possible that rapid unexpected changes in regional [fire] regimes...may be on the horizon” – Flannigan et al. 2009

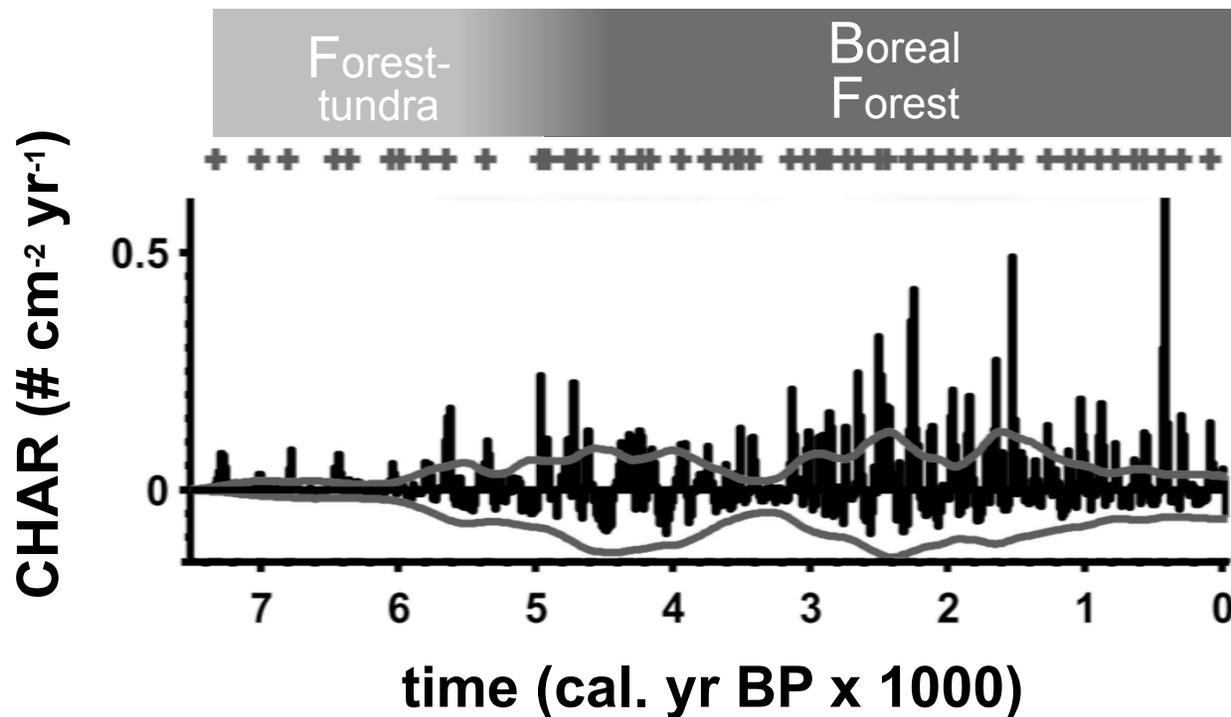
Non-linear response to temperature and moisture:



South-central Brooks Range, Alaska

****Changes in flammability can amplify or dampen the direct impact of climate***

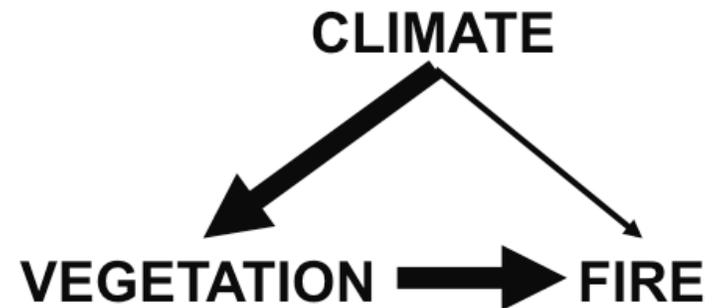
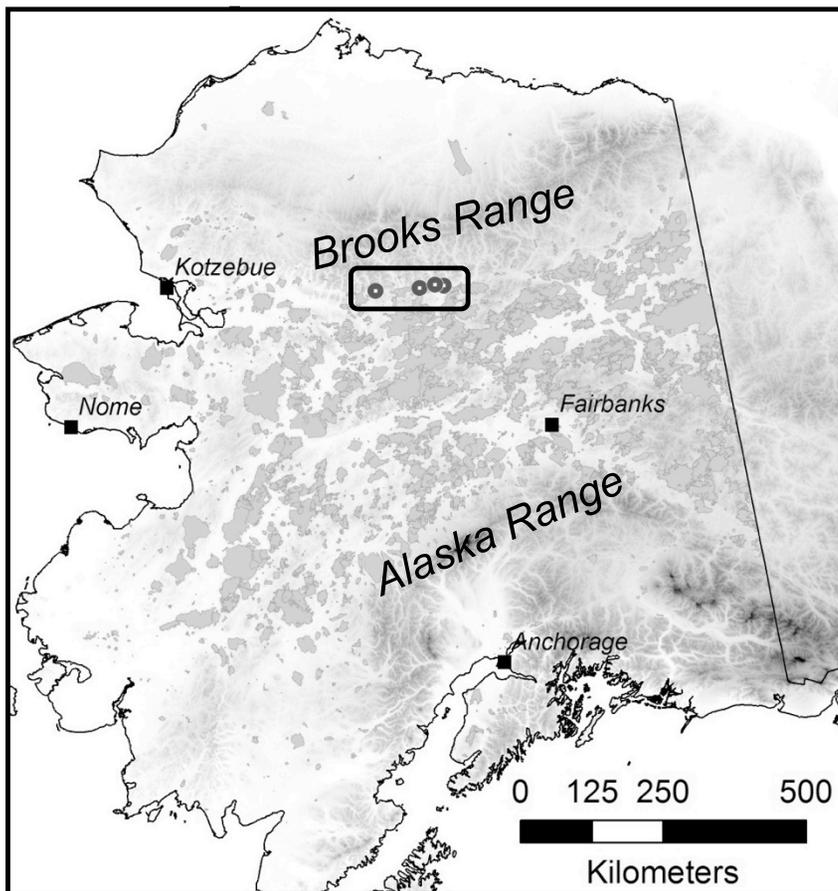
Long-term trend toward cooler/moister climate →



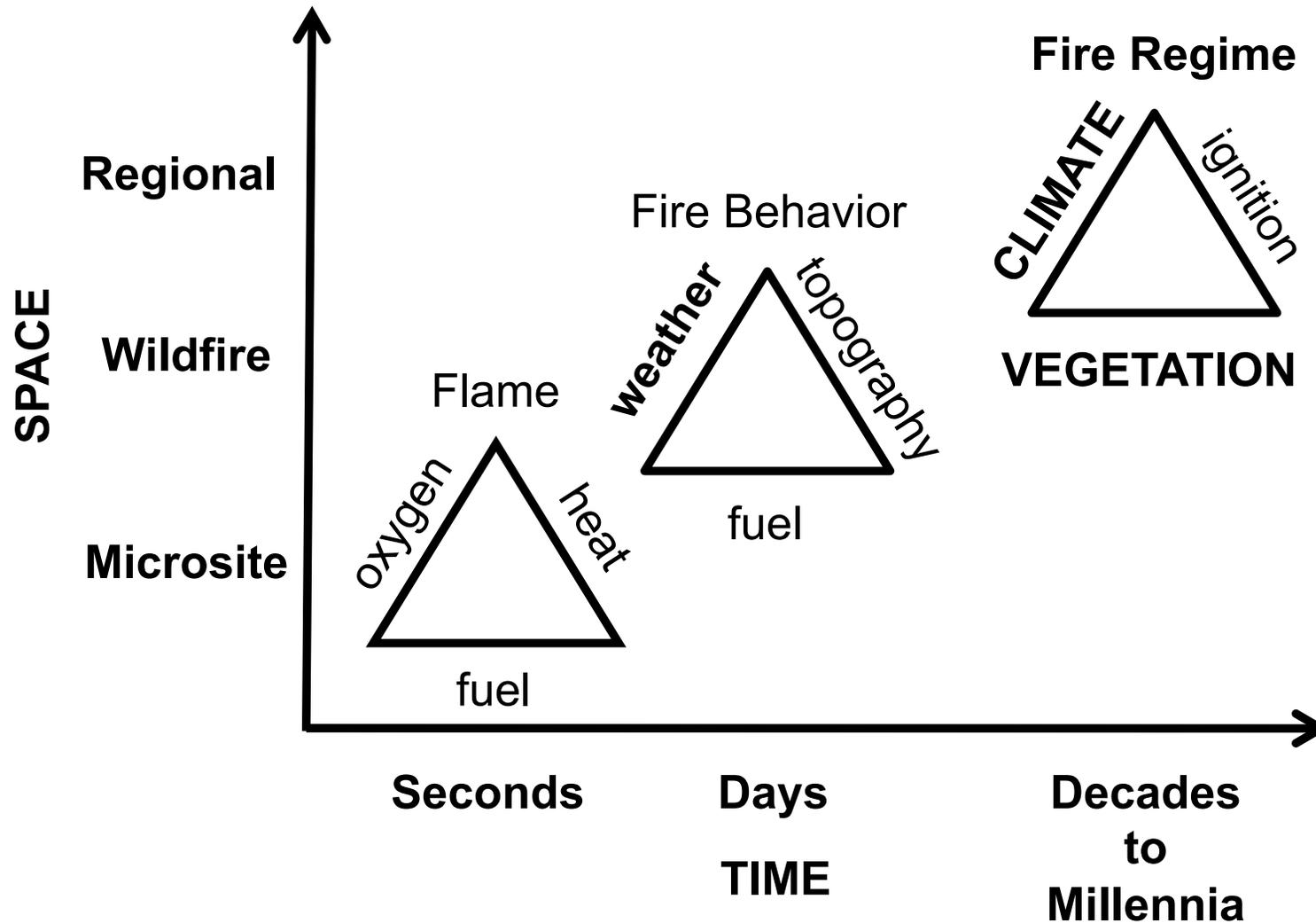
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South-central Brooks Range, Alaska

Large-scale shifts in vegetation mediate the impacts of climate change on fire



Conceptual Framework



Modified from Moritz et al. 2005, *PNAS*

Fire and Climate Change

“As a result of climate change, we are in essence conducting a global experiment such that future wildland fire activity is highly uncertain.” ***– Flannigan et al. 2009***